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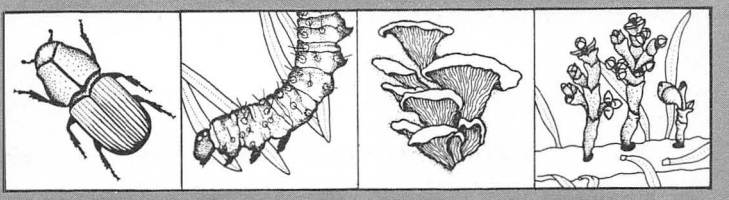

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THE EFFECTS OF HEIGHT GROWTH LOSS ON STANDS DAMAGED BY THE WESTERN SPRUCE BUDWORM

By

Wayne E. Bousfield, Entomologist

INTRODUCTION

The western spruce budworm 1/ routinely causes conspicuous damage to host trees in the northern Rocky Mountain States. Differential effects on host trees have been observed. True firs (grand fir and subalpine fir) display the most severe damage symptoms, whereas Douglas-fir and spruce are not damaged as severely in mixed host types (Bousfield and Williams 1977). The effect of defoliation on radial growth has been reported (Williams 1967); however, height growth reduction has been more difficult to measure. If only effects on top-killed trees are considered, the length of the top-kill can be measured; and the number of years growth involved in the top-kill can be calculated by adapting existing height growth models used to measure forest growth.

Prediction of normal height growth based upon diameter growth has been modeled for forest growth (stage 75). Functional forms of equations were derived to predict periodic height growth based upon tree height, diameter, diameter increment, and habitat type. Coefficients for 10 tree species growing on 10 habitat types have been developed.

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METHODS

A stand on the Clearwater NF near the West Fork of Squaw Creek which had been defoliated for about the past 10 years was examined and surveyed for damage. Trees were sampled using a 40 basal area factor (BAF) plot cruise for trees 5 inches diameter at breast height (d.b.h.) and larger, and a 1/300-acre fixed plot for trees under 5 inches d.b.h. Diameters were measured to the nearest one-tenth inch, and heights measured to the nearest 1 foot. Radial growth measurements for 10 years prior to the infestation and for the last 10 years were recorded for each tree. Defoliation intensities and the amount of top-kill was recorded by damage class.

The following is a description of the defoliation classes and top-kill intensities.

Class	Defoliation at Midcrown
1	Light defoliation - less than 10 percent of either new or old foliage removed by spruce budworm feeding.
2	Moderate defoliation - 10-70 percent foliage removed by spruce budworm feeding.

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3	Heavy defoliation - more than 70 percent foliage removed by spruce budworm feeding.

Class	Top-Kill Intensities
1	Light top-kill visible - less than 10 percent crown length dead.
2	Moderate top-kill - 10-33 percent crown length dead.
3	Heavy top-kill visible - greater than 33 percent crown length dead.

Some trees were felled to determine if ocular estimates corresponded with length of top-kill measured. Data were analyzed using the INDIDS computer program which compiles and calculates data by stand damage classes (Bousfield 1979). A height growth model developed by Stage (1975) was used to calculate the growth period in years of the dead top by species and damage class.

RESULTS

Top-kill was recorded on 12.8 percent of all trees in the stand, resulting in significant height growth loss (table 1). Data from felled trees showed that estimates of the length of dead top were accurate when grey-colored stems were the criteria used to assess the damage. Grand fir and subalpine fir had the most top-kill, with 12.3 and 21.2 percent trees per acre respectively. The spruce component had 8.7 percent top-killed. No top-kill was found in Douglas-fir. Top-kill intensity never exceeded 33 percent of the crown length.

Table 1--Length of top kill by species and damage class

Species	Light Top-kill >10% crown length (feet)	Moderate Top-kill 10-33% crown length (feet)
Grand fir	8.7	19.6
Subalpine fir	5.4	11.9
Spruce	9.6	19.8
Douglas-fir	0	0

Using Stage's (1975) model, the number of years of height growth affected was computed (table 2).

Table 2--Number of years of height growth killed by damage class and species

Species	Light Top-kill (years)	Moderate Top-kill (years)
Grand fir	10.5	25.6
Subalpine fir	6.9	15.1
Spruce	15.4	31.9
Douglas-fir	0	0

CONCLUSIONS AND DISCUSSIONS

In spruce budworm damaged areas, height growth loss can be a major factor in stand development. This survey was confined to top-killed trees. Estimates on height growth loss or nontop-killed trees was not attempted. Although spruce did not have as high a percentage of trees top-killed as the true firs, it did result in a greater amount when expressed in number of years. This may have been because spruce was larger and the growth model projected slower height growth on these trees. Subalpine fir had the highest percentage of host trees top-killed (21.2 percent), but the

growth period affected was the shortest. Subalpine fir average length of top-kill for both light and moderate severity classes was less than the other species, therefore not as many years were involved in height growth loss.

Height growth of Douglas-fir was not affected in this stand. This confirms previous observations that Douglas-fir is not severely damaged in mixed host types in northern Idaho.

REFERENCES

Bousfield, Wayne, and Ralph Williams. 1977. Impact of spruce budworm on the Nezperce NF, ID, 1976. Forest Insect and Disease Management. USDA Forest Service, State & Private Forestry, Missoula, MT.

Bousfield, Wayne. 1979. R-1 Forest insect & disease damage survey system. Forest Insect & Disease Management. USDA Forest Service, State & Private Forestry, Missoula, MT.

Stage, Albert R. 1975. Prediction of height increment for models of forest growth. USDA Forest Service Research Paper INT 164, Intermountain Forest & Range Experiment Station, Ogden, UT.

Williams, Carroll B., Jr. 1966. Differential effects of the 1944-56 spruce budworm outbreak in eastern Oregon. Pacific NW Forest & Range Experiment Station. USDA Forest Service Research Paper PNW 33.

Williams, Carroll B., Jr. 1967. Spruce budworm damage symptoms related to radial growth of grand fir, Douglas-fir, and Engelmann spruce. Forest Science, Vol. 13, No. 3.